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ELECTRICAL FORMULÆ.

THE use of formulæ for working out the results of the various electrical measurements which are constantly being made, either in the physical laboratory or in the submarine cable factory, is so frequent that a certain amount of mathematical knowledge is indispensable to those who have to deal with the subjects of electrical measurements and testing.

It is but natural that the electricians whose knowledge of mathematics is of a limited character should prefer to deal with formulæ which are as simple as possible, more especially if such formulæ are required to be in constant use. In cable factories where a large number of cables or lengths of core have to be daily tested, and the results of the tests worked out, it is especially desirable that any formulæ which it may be necessary to use, should be as simple as possible, but it is a constant source of complaint by tyro's in mathematical knowledge that an unnecessary amount of complication is given to these, and that for practical purposes they may be made of a much simpler nature than is usually the case. In fact, it is often hinted that the intricate forms given to the formulæ are more for the purpose of displaying the mathematical knowledge of the compiler rather than for any practical purpose.

Now, it is perfectly true that the use of intricate formulæ, unless absolutely necessary, should be avoided; but it is scarcely to be supposed that those who have had a high mathematical training should prefer complication to simplicty; the skill of the mathematician is more shown in the production of simple results than in intricate ones. The objection to the complicated formulæ, if the truth was known, would be found to lie in the incompetence of those who have to make use of them. We do not mean to say that needless complication is never introduced, and that there is not some justification in the outcry that is raised, but as a rule this is very seldom the case.

To obtain accurate, and sometimes merely approximate results, in electrical measurements, it is often imperatively necessary that formulæ be used whose appearance is not inviting, but such cases rarely occur, except when a little extra trouble or time expended can well be afforded in working them out.

In measuring the conductivity of the conductor of cables at a factory, but very little difficulty is encountered, and no calculation, or but very little, is required to get an exact result; when, however, a cable is laid, to effect the same test with accuracy is quite a different matter.

In this case earth currents may circulate in the wire, and an ordinary bridge test would not give a correct result. It is necessary in this case to take two tests, one with the battery current flowing in one direction, and another with this current reversed; to obtain the true resistance of the conductor from these two tests a formula is necessary in which the resistance of the testing battery and also the resistance of the galvanometer appears.

Now this formula, although not simple, is yet one which presents no real difficulty even to an unskilled mathematician: it is simply a question of adding and multiplying up several figures. Electricians however, it appears, cannot take the trouble to expend a few extra minutes in the working out, although an exact result is obtained by so doing, but must needs cry out for a simpler formula. As this cannot be obtained by any alteration of its form, they adopt the ingenious expedient of neglecting the resistances of the battery and galvanometer, and this is done the more readily as to determine their value involves a little extra trouble. Now as a matter of fact, the neglect of these quantities can very rarely, if ever, be made without so altering the formula as to render it practically useless for obtaining anything like accurate results; this, however, does not seem to be considered of any consequence so long as some kind of formula is employed.

It is surprising that this convenient practice of neglecting objectionable quantities in formulæ is so often adopted: it is by no means confined to the test we have been referring to. There is scarcely a book which deals with the subject of electrical measurement in which we do not meet with the expression, "The resistances of the battery and galvanometer may practically be neglected," and which might be with greater truth be written, "The resistances of the battery and galvanometer being awkward quantities and complicating the formula," had better be left out.

Cases of course do occur in which formulæ may be simplified so that they give very approximate, although not strictly correct results, but the reckless way in which this is done makes one doubtful of accepting their correctness, and is very misleading to learners.

HOCKIN'S METRE RESISTANCE BRIDGE.

THIS form of resistance balance for which we are indebted to Mr. Hockin is designed to compare resistances with an accuracy of ·01 per cent. As at present constructed, by Messrs. Latimer Clark, Muirhead & Co., it is represented by figure 1, and its theoretical arrangement is shewn by figure 2.

The two sides of the bridge or divided arc are formed by a thick platinum-iridium wire D E, containing 15 per cent. of iridium, supplemented at each end by two platinum silver resistance coils R R'. The platinum-iridium alloy is chosen for the wire, because it does not tarnish in the air, and therefore does not require to be cleaned. Platinum silver coils are preferred to those of German silver, as is well known, because of their altering in resistance with changes of temperature less than the latter, and of their not becoming brittle with age like many German silver coils. The diameter of the platinum-iridium wire is about two millimetres. It forms the

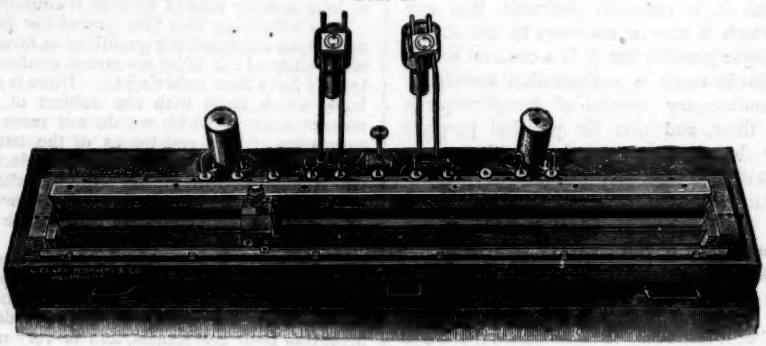
centre portion of the divided arc; the two coils forming the ends. The wire is a little over a metre long, and is fitted with a scale along its length, divided into a thousand millimetres, the zero of the scale being at the 500th division in the middle. The coils and the wire are connected by means of stout copper bars *r r'*, and mercury contact cups. The centre of the divided arc or point at which the galvanometer contact is made, consists of a movable contact maker, fitted to slide along the wire from one end of the scale to the other. Contact is made by it on pressing the knob, seen on its top part. This depresses a knife-edged style into contact with the wire. F is fitted with a terminal for attaching the galvanometer wire.

The coils to be compared C C', are connected to each other, and to the bridge by suitable mercury cups and stout copper bars. These cups and bars are so arranged that by merely reversing the position of the commutator H, the coils may be reversed in position on the bridge, that is to say, they may be made to exchange places. The bars can be easily raised out of the mercury by a convenient arrangement without unscrewing any of the terminals, and thus the ends which dip into the mercury can be readily re-amalgamated. This is done by dipping them for a minute or two into a solution of mercurous nitrate, and then drying them between bibulous paper. The ends of all the connecting bars which dip into the mercury cups should be carefully re-amalgamated before every accurate determination. The mercury acts as a fluid solder between the freshly amalgamated surfaces of the bars, and is, with the exception of direct soldering, the best known means of connecting two parts of a circuit.

In making a determination, the two coils to be compared should be maintained at the same temperature. For this purpose they should, if of uncovered wire, be immersed in heated parraffin or naphtha oil, or if they should be B A coils enclosed in water-tight cases, like those shown in figure 1, they may be immersed in a non-conducting liquid. The bridge is connected up to the battery B and galvanometer G, like the ordinary Wheatstone bridge, and the process of measuring is substantially the same. The balance is effected by sliding the contact piece F along the scale, and making trial contacts with the wire of the bridge until no deflection is obtained. One peculiarity of the measurement however consists in exchanging the positions of the coils on the bridge. First, a balance is got with the coils in one portion, say C to the left and C' to the right, as shown, and the reading taken, then by means of the commutator F the coils are reversed, C' being now at the left and C at the right, and a second reading is taken. By means of these two readings any scale error is eliminated. By taking half the difference of the two readings, and adding it to the smaller or deducting it from the larger, the true reading is obtained.

The object of adding the coils R R' to the bridge is to increase its delicacy, or, to put it another way, the use of these coils is to theoretically lengthen the wire D E; so that instead of one millimetre on the scale representing a difference in the resistances of the coils C and C' of, say 0·2 per cent., it may be made to represent a difference of only 0·1 per cent. In the bridge as made, each coil represents 9,500 millimetres of the wire, and each side of the bridge therefore amounts to 10,000 millimetres of the wire D E. The scale is, as we have said, divided into millimetres, and readings can easily be made to at least a millimetre, so that a difference between C and C' of 1 in 10,000, or 0·01 per cent., is easily observed.

FIG. 1.



The following method of finding the values of the resistances of the coils R and R' in terms of the wire D E is wholly taken, with the exception of some necessary changes in the description, from an excellent paper by Mr. Hockin and the late Dr. Mathiessen, in the first volume, and September number of the "Laboratory," a chemical journal published in 1867, but since defunct.

Let R be the resistance of the coil R. Let *r* be the resistance of the connecting bars and mercury cups, which, with the coil R, make up the circuit from 1 to the point of the wire D E, touched by the galvanometer terminal E when the pointer is exactly at the left extremity of the scale. Let R' *r'* be the resistances of similar quantities for the other half of the bridge.

The resistances of R R' *r r'* are to be found and expressed in millimetres of the wire D E, that is to say, the length of such a wire as D E, having a resistance equal to R R', &c., is to be found.

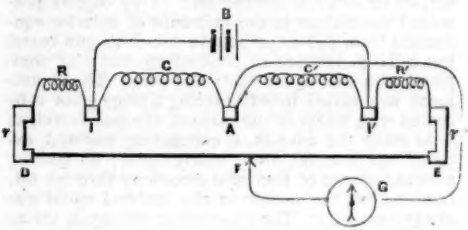
In order to do this remove the coil R R', and substitute for it a thick bar of copper. Insert a coil between A and I of known resistance, a, and between A and I another coil of known and smaller resistance, b, and let x be the reading on the scale when no current passes through the galvanometer. Then

$$\frac{R + r + x}{1000 - x + r'} = \frac{a}{b}$$

$$R + r = \frac{a}{b}(1000 - x) - x + \frac{a}{b} r' \quad \ldots\ldots 1$$

This equation involves the unknown and very small quantities r and r'; but r' comes in multiplied by $\frac{a}{b}$, a large quantity, therefore r r' must be found, or the value found for R may be considerably

FIG. 2.



too small. The most trustworthy record for finding r and r' is the following:

Join I D and I' E by two thick copper bars. Between I and A put a coil of resistance a, and between I' and A put a coil of resistance b, and let a be many times greater than b.

Suppose $a = 100\ b$.

Take the reading on the scale when no current passes through the galvanometer.

Reverse the coils a and b, putting b for a, and a for b.

Take the reading again.

Let x be the reading in the first case, and let x' be the reading in the second case.

Then $$\frac{r + x}{r' + 1000 - x} = \frac{a}{b}$$

and $$\frac{r + x'}{r' + 1000 - x'} = \frac{b}{a}$$

and from these two equations we get

$$r = \frac{bx - ax'}{a - b}$$

$$r' = \frac{b(1000 - x') - a(1000 - x)}{a - b} \quad \ldots\ldots 2.$$

The numerical values of r and r' are calculated from these equations, and substituted in equation 1, which then gives the true value of R.

ELECTRICAL CONDUCTION.

By Prof. R. C. KEDZIE.

IN the Farmers' Institutes of last winter I spoke of lightning rods, their forms and construction, and endeavoured to tell farmers how they could put up their own rods, with a very large saving of expense. I stated that the highly artificial forms so generally in use, such as fluted rods, wire ropes, flat strips, etc. were not essential features of a good rod, and that of increase of conducting power. On this last statement a warm discussion arose, and Professor Henry, Secretary of the Smithsonian Institution was quoted as authority for the doctrine of conduction of electricity of high tension at the surface. Out of this came the correspondence and investigation which I now present to you, beginning with the letters of Professor Henry, which he has kindly permitted me to use.

Prof. Henry's letters, with his final corrections, are as follows:

SMITHSONIAN INSTITUTE, WASHINGTON,
March 11, 1876.

DEAR SIR,—In answer to your letter of the 7th inst., I have to say that the discrepancy which exists as to the question whether electricity passes at the surface or through the whole capacity of the rod has arisen principally from experiments on galvanic electricity, which having little or no repulsive energy, passes through the whole substance of the rod, and also from experiments in which a very large quantity of frictional electricity is transmitted through a small wire; in this case the metal is resolved into its elements and reduced to an impalpable powder.

In the case, however, of the transmission of atmospheric electricity through a rod of sufficient size to transmit the discharge freely, there can be no doubt that it tends to pass at the surface, the thickness of the stratum of electricity varying with the diameter of the rod and the amount and intensity of the charge.

To test this by actual experiment I made the following arrangement: through a gun-barrel about two feet in length a copper wire was passed, the ends projecting. The middle of the wire in the barrel was coiled into the form of a magnetizing spiral, and the ends of the gun-barrel were closed with plugs of tin foil, so as to make a perfect metallic connection between the wire and the barrel. On the outside of the barrel another magnetizing spiral was placed, the ends of which were connected near to the ends of the barrel.

A powerful charge was now sent through the copper wire from a Leyden jar of about two gallons capacity. The needle within the barrel showed not the least sign of magnetism, while the one on the outside was strongly magnetic.

From this experiment, I conclude that a gas-pipe can convey an ordinary charge of electricity from the clouds as well as a solid rod of the same diameter.

The repulsive energy of the electrical discharge at right angles to the axis remains of the same intensity as in the case of a statical charge. This I have shown to be the case by drawing sparks of considerable intensity from a conductor, one end of which was connected with the ground while sparks were thrown on the other end from a large prime conductor. This spark is of a peculiar character, for though it gives a pungent shock and sets fire to combustible substances, such as an electrical pistol, it does not affect a sensitive gold leaf electrometer. The fact is, it consists of two sparks, the one negative and the other positive. The rod during the transmission of the electricity through it is charged + at the upper end and immediately in advance of this

point is charged — by induction, and the electricity passes through it in the discharge in the form of a series of + and — waves.

Yours very truly,

Prof. R. C. Kedzie, Lansing, Michigan. JOSEPH HENRY. Sec. Smithsonian Inst.

SMITHSONIAN INSTITUTION, WASHINGTON, D.C.
April 15, 1876.

R. C. Kedzie, Lansing Mich.

DEAR SIR,—Your letter was received by due course of mail, but a press of business connected with the preparation of the annual report for 1875, and the lighthouse board has prevented an earlier reply.

I have now to say that as far as I know I am the only person who has made a special study of the conduction of frictional electricity in regard to lightning rods. It has long been established by Coulomb and others that the electricity of a charged conductor exists in a thin stratum at the surface, and this is a necessary consequence of the repulsion of electricity for itself, every particle being repelled from every other as far as possible. From this it was hastily assumed that electricity in motion also moves at the surface; but this was an inference without physical proof until I commenced the investigation. I found from a series of experiments that *frictional* electricity, that is, electricity of repulsive energy, such as that from the clouds, does pass at the surface, but that *galvanic* electricity, the kind to which Faraday, Daniell, De La Rive and others refer, passes through the whole capacity of the conductor. This latter fact, however, was previously established by others. I further found that whenever a charge of electricity was thrown on a rod explosively, however well connected the rod was with the earth, it gave off sparks in the course of its length sufficient to fire an electric pistol and light flocculent substances. I also found that in sending a powerful discharge from a battery of nine (9) jars through a wide plate that no electricity passed along the middle of the plate, but that it was accumulated in its passage at the edges.

From all my study of this subject I do not hesitate to say that the plan I have given of lightning rods is the true one, and that a tube of a sufficient degree of thickness serves to conduct the electricity as well as a solid mass, provided the thickness is sufficient to give free conduction. A very heavy charge sent through a wire frequently deflagrates it, but no discharge from the clouds, of which I have any knowledge, has ever sufficed to deflagrate a gas-pipe of an inch in diameter.

The plan of increasing the surface of a rod by converting the metal into a ribbon is objectionable. It tends to increase the power of the lateral discharge, and gives no increase of conducting power.

Another fallacy is much insisted on, viz., the better conduction of copper than iron. It is true that copper is a better conductor of *galvanic* electricity, which pervades the whole mass, but in regard to *frictional* electricity the difference in conducting capacity is too small to be of any importance. Iron is sufficiently good in regard to conduction, and withstands deflagration better than copper; besides this, it is much cheaper.

Yours truly,

JOSEPH HENRY.

On the one side we have Professor Henry stating that conduction of electricity of high tension is *at the surface* of a conductor; on the other side we have the statement of men distinguished in science who affirm that this, like other forms of electricity, is conducted *through the mass* of the conductor, and is not confined to the surface, as in the statical condition.* The question thus arises, what is the path of conduction in electricity of high tension?

The experiment of Professor Henry with a magnetising spiral inside a gun-barrel is a very striking one, and at first sight it seems conclusive against the doctrine of internal conduction of electricity of high tension. I repeated his experiment and found the needle in the internal magnetising spiral only very feebly magnetic, while the needle in the external spiral was strongly magnetic. Can these results be explained in any way except by the assumption of surface or exterior conduction? Two objects presented themselves to the inference of exterior conduction from this experiment: 1st. The gun-barrel has a large amount of conducting material compared with that of the contained wire. The experiment was varied by substituting a large glass tube coated with tinfoil in the place of the gun-barrel, so as to make the amount of conducting material, external and internal, more nearly equal; on passing a strong charge of frictional electricity through this combination, the needle in the internal spiral was *strongly magnetic*. The experiment was again varied as follows: a piece of inch gas-pipe twenty-six inches long was substituted for the gun-barrel; in this a stout piece of copper wire (one-sixth inch in diameter), was inserted, the wire being coiled into a magnetising spiral, and a steel needle being placed in the axis of the spiral; on passing a charge from a battery of ten two-quart Leyden jars, the needle in the internal spiral became magnetic, but less strongly than that in the spiral in the glass tube coated with tin-foil.

This raised the question whether the electricity which passes by the internal wire expended the whole of its magnetising influence upon the needle within the spiral, or was a portion expended upon the surrounding iron tube, whether gas-pipe or gun-barrel? This question was submitted to experiment as follows: Two spirals having the same number of coils were formed from the same piece of wire; in the axis of these spirals two needles as nearly alike as possible were placed; one of these spirals was placed in a long glass tube (to insure more perfect insulation), and this tube was placed inside a gas-pipe; the other spiral was outside the gas-pipe and a few inches from it; two ends of the wire were then made clean and bright, twisted together and capped with a brass ball; the other two ends were also made clean and bright, twisted together, and connected with the outside coating of the battery of Leyden jars.

* *Conduction.*—"In all cases where electricity is in motion, whether it be excited by chemical action, as in the voltaic pile, or by friction, as in the common electrical machine, the force is conveyed by the entire thickness of the conductor; the charge is not confined to the surface, as occurs when the power is stationary, and produces effects by induction only. In the case of the voltaic current as well as in the momentary discharge of the Leyden battery, by far the greater proportion of the induction occurs between one transverse section of the conductor and the adjacent sections immediately before and behind it; and but a small proportion of the induction, sufficient however to be distinctly manifest, is diverted to surrounding objects."—*Miller's Chemical Physics, pp.* 404-5.

Here two perfectly equal paths were open for the passage of electricity, and if a charge were passed from + to — the electricity would divide, and equal amounts pass by each conductor, and the needle in both spirals would exhibit the same amount of magnetic intensity unless the iron tube exerts a modifying influence over the magnetising power of the internal spiral. The experiment was tried repeatedly, and uniformly the needle in the internal spiral was inferior in magnetic intensity to the needle in the external spiral usually in the proportion of two to five.

We thus see that the conditions attending Professor Henry's experiment, instead of the simplicity which they at first sight seemed to have, were in fact quite complex. The intensity of magnetism developed in the needle in the interior spiral cannot be accepted as a true measure of the amount of electricity which passed through the interior wire.

Prof. Henry concedes that galvanic electricity has little or no repulsive energy, and passes through the whole substance of the metallic rod. The question then arose, can galvanic electricity be made to exhibit a similar tendency to surface action? To render the answer decisive the conditions of experimental proof were purposely made such as would favour an answer in the negative. A half-inch gas pipe was used for the internal conductor; outside this was placed a long glass tube, covered for five-sixths of its length with tin-foil for the external conductor; the tin-foil embraced the gas-pipe at one end, while the other end of the foil terminated in a long copper wire which was coiled into a magnetising spiral, and a very sluggish galvanometer was also introduced into this part of the circuit to measure the intensity and the direction of the flow of electricity; the wire from this exterior circuit was twisted up with a wire prolonging the gas-pipe.

On passing a current of galvanic electricity from + to —, the needle of the galvanometer was violently deflected, and a soft iron wire in the magnetising spiral was made magnetic. This experiment reproduces with *galvanic* electricity the same apparent tendency to surface action, which was so strikingly exhibited in Professor Henry's experiment with *frictional* electricity. In this experiment no one will attempt to explain this division of the current, and the passage of a part of the electricity through the exterior conductor by any assumption of repulsion which exists in the statical condition of frictional electricity, because galvanic electricity is devoid of all repulsion. Will not the following proposition cover all the essential facts in both experiments? viz: the resistance to the passage of a current of electricity being directly as the amount of electricity, and inversely as the conductive capacity of the conductor, and electricity of the same kind having absolutely no cohesion, when two paths are open for the passage of a current of electricity the current will divide and pursue both paths, most by the path offering least resistance, and least by the path of greatest resistance.

Since the gun-barrel exerts such a controlling influence over the magnetising power of an inclosed spiral, the intensity of the magnetised needle in such a spiral was discarded as a measure of the amount of electricity which traverses such spiral, and some other more accurate means of measuring the relative amount of electricity which passes by the interior and exterior circuits was sought for. Failing in my efforts to construct electrical thermometers of sufficient accuracy for this purpose, *the striking distance* was finally selected for such measurement. A stout copper wire capped with a brass ball at each end was placed inside the gun-barrel; at one end it was brought into metallic connection with the gun barrel by means of tin-foil, but insulated from it for the rest of the distance by a glass tube; an L shaped piece of the same kind of wire was bound to the other end of the gun-barrel by securely wrapping with copper wire; this L piece was also capped with a brass ball, the balls of the exterior and interior wire being opposite each other, and about three inches apart; a branched rod capped with brass balls, and terminating in a wire which could be brought in contact with the outside of a Leyden jar completed the apparatus.

The arrangement in this apparatus so far as regards external and internal conduction is similar to Professor Henry's; it differs from his mainly in the fact that the relative amount of conduction is not measured by the action of a magnetising spiral, but by the distance across which a spark will leap. If conduction is solely at the surface, and there is no conduction by the interior mass of a conductor, then if the balls of the branched rod are placed at the same distance from the balls of the interior wire and the L wire, when a Leyden jar is discharged through this apparatus from + to —, the spark should always leap from the ball of the L rod to the contiguous ball of the branched rod, and never from the ball of the interior wire to the corresponding ball of the branched rod. When the experiment was tried under these conditions *the spark always leaped from the ball of the interior wire.* This experiment seems to show that conduction of *frictional* electricity may be by the interior mass of a conductor as well as at its surface.

The experiment was tried to see if this kind of electricity could be withdrawn from the interior of a conductor during its passage. Into the opposite ends of a T gas-coupling gas-pipes were firmly screwed; one end of the gas-pipe was securely closed by screwing on a brass cap; into the third opening of the T coupling a glass tube was securely cemented, the glass tube being covered with shellac varnish to secure good insulation; a copper wire was passed through the glass tube so as to touch the inside of the gas-coupling, and the projecting portion of the wire was coiled into a magnetising spiral; the free end of the wire was then twisted with a wire attached to the open end of the gas-pipe.

When a steel needle was placed in the spiral and a Leyden jar discharged through the apparatus from + to —, the needle was found to be magnetic, thus showing that frictional electricity may be withdrawn from the interior of a conductor during the passage of a charge of such electricity. A critical friend objected that the electricity was still withdrawn from a surface, although it was an interior surface. To remove this objection a cylinder of lead was cast, conducting wires being inserted in each end of the lead cylinder; a deep hole was drilled in the side of the cylinder, in which a glass tube was cemented; through this tube a copper wire was passed down to the lead, and the rest of the apparatus was arranged as in the former experiment. When a Leyden jar was discharged through this

apparatus, the needle in the spiral became magnetic as in the former experiment, showing that electricity during its passage could be withdrawn from the centre of a solid body. These facts seem to me to be inconsistent with the supposition that electrical conduction is confined to the surface of a conducting body.

As another proof of the theory that conduction of frictional electricity is at the surface of a conductor, Professor Henry cites the fact that when electricity is thrown explosively upon a rod well connected with the ground, a lateral spark may be drawn from such a rod. To examine this matter an iron rod was brought into good metallic connection with a large steam pipe (not in use), which was buried in the ground for more than 600 feet of its length, thus securing ample connection with the earth. When electricity was thrown explosively upon this rod from a large prime conductor, a lateral spark could be drawn from any part of the rod, and even from the projecting end of the steam pipe. On passing a metallic rod capped with a brass ball into the inside of the steam pipe, *the lateral spark could be drawn from the inside of the pipe.* This fact seems to me to be irreconcilable with the statement that "the repulsive energy of the electrical discharge at right angles to the axis remains of the same intensity as in the case of a statical charge," because in the statical condition no electricity can be drawn from the interior of a charged prime conductor.

The question whether electricity sent through a wide plate will all accumulate at the edges and no part pass along the centre of the plate, was submitted to experimental test as follows: parallel strips of tin-foil were pasted on a wide plate of glass, the ends being connected by cross strips of tin-foil; the parallel strips of foil were then divided into a large number of squares by drawing a sharp knife across them, so that the track of the electrical discharge could be traced by the light at points of interruption in the strips of foil.

On passing strong discharges of electricity through this apparatus, the path of the discharge was sometimes by the side strips of foil, but most frequently by some of the interior strips. It seemed to be governed by caprice—rarely twice in the same path. Trifling variations seemed to determine its path, *e.g.*, the presence of moisture by the breath or a touch of the hand, or the proximity of a body upon which it could act inductively, such as a metallic rod under the glass. I did not find that uniform discharge along the edges which I had anticipated.

I conclude this subject by saying that, much as I honour the distinguished Secretary of the Smithsonian Institution, on reviewing the whole subject, even in the light of his ingenious experiments, I am led to coincide with the views of the great mass of eminent electricians both in Europe and America, viz.: that conduction of electricity of whatever name is through the mass of the conductor, and not by surface action such as is exhibited in the statical condition of electricity.—*Journal of the Telegraph.*

WITH reference to a note which appeared in our last, we are informed by the West Coast of America Telegraph Company that it is the Serena Valparaiso section of their cable only which is broken. There is, we understand, no interruption to the traffic, as it is conducted over the land lines.

JOHNSON AND PHILLIPS' PATENT INSULATORS.

ALTHOUGH the production of an efficient form of insulator for aerial wires is a most interesting and important problem, the advance made in this branch of practical telegraphy has by no means been as great as could be wished.

The employment of a liquid repellant of moisture placed in a recess formed around the ordinary cup form of insulator was, we believe, attempted some years ago; but either through the imperfect way in which the experiment was made or in consequence of the utility of a very high state of insulation, not being so apparent as it is at the present day, when economy of battery power and the employment of the duplex and quadruplex systems of working are points of great importance, the idea was not carried into practice. Messrs. Johnson and Phillips, who have paid considerable attention to the production of an efficient form of insulator on the above principle, have so far succeeded as to obtain patterns which have proved efficient under conditions which would be fatal to those of the ordinary form.

Although these insulators require the test of continued use under conditions that exist in ordinary aerial telegraph lines, yet the success that has been obtained is so remarkable as to deserve notice.

Figs. 1, 2, and 3, show forms of these insulators.

Fig. 1. This insulator is fixed above its arm or support in the usual manner. The lower edge of the porcelain A is turned up inwards so as to form a chamber, shown at S, in which oil or some other insulating fluid is placed.

Fig. 2. In this insulator the porcelain consists of two parts. A, the head, is firmly cemented to the bolt P, which passes freely through the second part B, containing the insulating fluid S. B is held in position by the nut N; when this nut is unscrewed B may be lowered so as to expose the oil chamber S to view for the purpose of examination or for the introduction of the oil.

In both cases the insulators are easily filled with the oil or other insulating fluid by means of a long-necked syringe.

Fig. 3 shows how an ordinary porcelain insulator may have the insulating fluid principle applied to it. The cup-shaped space S is partly filled with the fluid. C is a dished metal cover resting upon the porcelain tube T. This cover is not fixed, but is free to rotate round the bolt P; a fan F, attached to this cover causes it to rotate from time to time by the action of the wind, the object being to break any spiders' webs or filaments which might cause a leakage from the surface of the insulator to the cover. An india-rubber ring W prevents the rain from entering the oil chamber by means of the hole in the cover through which the bolt passes; it also, when properly placed, prevents the cover C from being tilted up by the wind and touching the porcelain. This form of insulator is especially adapted to districts infested with spiders or other web-spinning insects.

The following tests taken on twenty of the patent insulators and on four ordinary white porcelain insulators with a porcelain tube round each bolt speak for themselves.

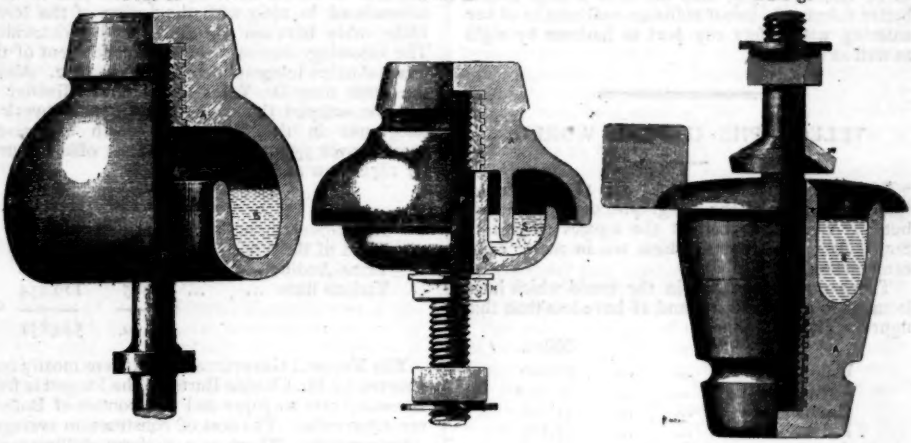
The loss obtained on the four ordinary insulators is

multiplied by five, to make it comparable with the twenty patent insulators, which are assumed to represent a mile of line.

The tests were taken with eighty cells, and an astatic mirror galvanometer.

The absolutely uniform insulation shewn for the patent insulators, is not strictly correct, but the deflection obtained on them never being more than

FIG. 1. FIG. 2. FIG. 3.



two divisions, it was impossible to detect small alterations in the insulation.

Date.	Resistance in Megohms per mile. (20 insulators)		Remarks.
	Patent.	Ordinary.	
January 15	—	—	Insulators fixed.
,, 31	about 14200	254·	Fine morning.
February 1	,,	2·62	Fine rain; raining nearly all night.
,, 3	,,	31·18	Bright morning.
,, 5	,,	16·85	Fine; frosty.
,, 6	,,	9·67	Dull; overcast; has rained in night.
,, 7	,,	17·71	Dull; overcast.
,, 9	,,	7·21	Fine, but damp with dew.
,, 10	,,	8·74	Overcast; windy.
,, 12	,,	23·38	Dull: overcast.
,, ,	,,	1·10	Shower of rain.
,, 13	,,	16·04	Dull; overcast.
,, 15	,,	9·33	Dull; overcast; damp.
,, 16	,,	38·10	Overcast.
,, 17	,,	48·98	Fine.
,, 19	,,	5·72	Raining yesterday, and during night; now fine.
,, 24	,,	3·72	Dull; overcast; has been raining.
,, 26	,,	·71	Rain and hail; strong wind; insulation rose to 83 megohms shortly after rain ceased.
,, 28	,,	1437·	Fine; bright; sharp frost.

The above figures show the great effect which surface leakage has upon the insulation of an ordinary line; the test taken on February the 12th was very marked, when the insulation of the ordinary insulators fell from 23 megohms to 1·1 megohm in a few minutes after the rain commenced. On the 26th it was equally instructive to notice how the insulation rose, when, the rain and hail ceased, and the strong wind blowing at the time, dried the surface of the insulators; the change in this case also took place in a few minutes.

The rain on the 26th had cleaned the surface of the insulators, hence the high insulation obtained during the sharp frost on the 28th.

The tests were taken at about 7 a.m.

While all these changes were taking place in the ordinary insulators, it will be noticed that the high insulation given by the patent insulators, remained perfectly constant (as far as could be detected).

It should be noted that under the influence of frost the insulation still remained good, although it might have been expected that the coagulation of the oil would have prevented such a favourable result being obtained.

ELECTRIC LIGHT.

THE S.S. *Faraday* while moored at Gravesend, previous to her voyage to America, was illuminated at night time by the electric light which she carries.

The apparatus for producing the light is of Messrs. Siemens' construction, and known as the "Dynamo Electric Light Apparatus;" it gives an intensely brilliant light equal to from 4,000 to 6,000 normal candles.

A separate steam engine is placed on the deck to drive the apparatus, which absorbs about 3 HP when the light is burning.

The electric lamp, which is also of Messrs. Siemens' invention and manufacture, was placed on the port-side of the bridge, so as to throw a light over to the shore, and enable the boats attending on the ship to work with perfect safety throughout the night; the advantage and success of these night operations was proved beyond a doubt.

The light was so brilliant that persons on shore

at a distance of over a quarter of a mile from the ship, could read ordinary writing with perfect ease.

While at sea, the lamp is placed at the mast head, and in this position it also gives very satisfactory results.

A vessel carrying so powerful a light is better able to sight any distant objects on dark nights, and she herself can be clearly seen by other ships, thus the electric light, besides enabling loading and unloading to be done at night, also provides a ship with a better safeguard against collision, and admits of her entering with safety any port or harbour by night as well as by day.

TELEGRAPHS OF THE WORLD.

"THE Statesman's Year-book" for 1877, gives an interesting table of the telegraphs of all countries, but we venture to correct the figures respecting South American States, which are in many cases erroneous—

There are 15 countries in the world which have from 5,000 miles upward, and 16 have less than that figure. The former are :

	Miles.
United States	79,000
Great Britain	75,000
Russia	31,459
France	28,784
Austria	28,148
Germany	19,152
Australia	18,448
Turkey	17,618
India	15,705
Italy	12,622
Canada	13,995
Sweden-Norway	9,041
Spain	7,510
Mexico	5,760
Arg. Republic	5,530

It will be seen that this Republic (The Argentine) is the only country in S. America, which possesses over 5,000 miles of telegraphs, but if Brazil were to count also the ocean cables she would stand even before this country, and rank beside the Dominion of Canada.

The returns for the various states of South America are as follows :

	Miles.
Arg. Republic	5,530
Brazil (land)	2,825
Ocean cables	7,900
Chile	2,650
Peru	608
Bolivia	475
Ecuador	210
Uruguay	958
Columbia	810
	21,966

We are unable to ascertain the first telegraph line constructed in this continent, but it was probably on the Panama railway in 1851, or perhaps from Valparaiso to Santiago a year later. Although S. America was the last great section of the globe to be united by cable to Europe the telegraph system is now so widely spread that a message can be sent in a few hours from the mouth of the Amazon to the shores of the Pacific and from the remotest confines of the Argentine Republic and Bolivia to the chief cities of South America or the great capitals of Europe.

The great development of telegraphs in this continent is of recent date, and may be said to have commenced in 1869 with the laying of the River Plate cable between B. Ayres and Montevideo. The following year saw the commencement of the Trans-Andine telegraph, completed in 1872. About the same time Dr. Velez Sarsfield, as Minister of Interior, ordered the construction of a network of telegraphs in the Provinces, which at present extends over 3,000 miles. The Post office returns for 1876 shew as follows :

	Miles.	Messages.
Nat. Government ...	3,110	302,721
Govt. of B. Ayres ...	415	77,036
Trans-Andine	620	31,640
Various lines	1,385	129,434
	5,330	540,831

The National Government lines were mostly constructed by Mr. Charles Burton ; the longest is from Buenos Ayres to Jujuy and the frontier of Bolivia, say 1,700 miles. The cost of construction averaged £100 per mile. There is a uniform shilling tariff, and the receipts only reach 75 per cent. of the working expenses, £33,000 per annum. The Provincial Government line to various camp towns and Rosario was constructed by Mr. Trant, the present manager, and has proved a paying investment. The Trans-Andine line, made by Messrs. Clark & Co., with subsidies from the Chilian and Argentine Governments, is rapidly increasing in business, the latest dividends varying from 12 to 16 per cent. per annum. No less prosperous an undertaking is the River Plate Telegraph Company, under the able management of Mr. John Oldham, who superintended the first construction, and has ever since directed this line. As regards the railway lines, their returns are included with the railway traffic.

Brazil has two land-lines ; the northern to Bahia, which transmits 21,000 messages annually ; and the southern to Uruguayana, 51,000 messages per annum. Both lines belong to Government ; they were begun in 1866, and completed in 1874. The annual receipts average £19,000, expenses £70,000, leaving a considerable loss to the imperial treasury.

The Brazilian Atlantic cable, laid in 1874, was conceded to Viscount Maua, who transferred his rights to an English company called the Brazilian Submarine. The capital was £1,300,000, and the company afterwards made an arrangement for partition of earnings with the Western and Brazilian, capital £1,600,000, and the Platino-Brazilian Co., capital £400,000. The cables belonging to these companies exceed 8,000 miles, extending from the River Plate to the mouth of the Amazon and the West Indies, and connecting Pernambuco with Portugal.

Chilian lines belong to the Government ; they have 55 telegraph stations, and a total length of

2,650 miles, but give very poor returns. The budget for 1878 estimates the total receipts from Post Office and Telegraphs as low as 70,000$f., say £13,000, or one-half the earnings of the Argentine Government lines.

Respecting the Peruvian lines we have no returns, nor any of the Pacific cable now being laid down by an English company from Valparaiso to Panama, which we believe is already working as far as Callao.

Neither do we know anything about the lines in Bolivia, Ecuador, or Columbia, which probably belong to the Governments of those republics.

Uruguay has 958 miles of telegraph, in two principal lines, which belong to the Platina Brazilian Company, one from Montevideo to Yaguaron and Rio Grande, the other to the chief ports of the River Uruguay.—*The Standard and River Plate News.*

THE POSTAL TELEGRAPH DEPARTMENT.

THE Report of the Postmaster-General, says *Engineering*, which has hitherto covered the period of one year only, in the present instance embraces a period of fifteen months. Previous reports have been rendered under the calendar year, but with the approval of the Treasury the present one is made to terminate with the financial year, and in future the period embraced by the financial year will be that for which these reports will be issued.

On the 12th of April, 1876, the department acquired by purchase the undertaking of the Orkney and Shetland Islands Telegraph Company. It is remarked "there is, of course, no prospect of the transaction proving remunerative to the department. It will, however, no doubt, confer a great benefit upon the inhabitants of the islands." No doubt this will be the case inasmuch as the acquirement of the cables and lines in question by the Government places those islands on a level, telegraphically, with other parts of the kingdom, the rate per twenty words being reduced to one shilling. With a view to obviate, as far as possible, the serious interruption to which the lines were subjected on three separate occasions by heavy snow-storms, and to prevent the recurrence of accidents which has happened in consequence of the fall of wires in crowded thoroughfares, a considerable mileage of overground lines have been replaced by underground wires. At the time of the acquisition by the State of the telegraphs the total length of the underground wire was 1,928 miles. On the 31st of March last it was 8,014 miles.

With regard to the proposed reduction of the engineering staff, the Postmaster-General remarks: "Having satisfied myself that it was no longer necessary to maintain the engineering staff of the telegraph service at the strength which was required for some time after the transfer of the telegraphs to the State, I had taken the question of reduction into consideration, and a scheme for that purpose was nearly matured, when a Committee of the House of Commons was appointed to inquire into the organisation and financial system of the telegraph department. My proposals thus obtained the advantage of Parliamentary criticism, and are now being carried out."

A rigid examination into the establishments at all offices has also been made, and considerable reductions have been effected. The training of military telegraphists is to be extended, the area of country to be supervised by officers of the Royal Engineers has, with this object, been enlarged, and 160 Royal Engineers are to be employed within a district comprising the whole of the south of England from the mouth of the Thames to the Land's End.

The continued depression of trade has led to a large number of renters of private wires terminating their agreements with the department, and still other and new contracts, bringing in an additional rental of £707 have been entered into. The net revenue derived from this branch for the financial year to the 31st March last, was £58,942.

The only arbitration between the department and the railway companies claiming vested rights in the telegraphs acquired by the State, dealt with during the period referred to, was that of the North-Eastern Railway Company. The claim made by the company was £540,292 with interest at 5 per cent. from February, 1870. The award amounted to £168,696, or less than one-fourth of the claim.

The gross earnings of the telegraph service for the year to March 31, amounted to £1,313,000 as compared with £1,277,000, the amount of the earnings for the previous year, thus showing an increase of £36,000. The expenditure, however, is in excess of that for the previous period, the amount for the year 1876-77 being £1,123,000 as compared with £1,032,000, showing an increase of £91,000. It is, however, pointed out that these figures, which exhibit an apparent increase of expenditure far greater in proportion than the increase of revenue, must be subjected to considerable modification if the real revenue and working expenses of the year are to be clearly shown. A reduction in revenue has arisen from the introduction of the telegraph stamp, whereby the revenue of the preceding year was abnormally swollen. On the other hand, the expenditure includes no less than £30,429 for the telegraph share of the cost of the site of the new post-office at Manchester, together with large sums paid to railway companies on account of arrears due for the preceding years. The true financial results of the telegraph business for the year will, it is said, be exhibited in the profit and loss accounts to be presented shortly to Parliament. The depression of trade during the year is considered to have effected the telegraph revenue to a much greater extent than it has the postal revenue.

The total number of messages for the fifteen months is 26,440,439 as against 20,766,277 for the previous twelve months. Reducing the former quantity to a like period in order to compare it with the latter, the result is that for the financial year ended the number of telegrams may be taken as 21,152,351, showing an increase considerably below that for the previous year.

No mention is made of the extent of additional wires provided during the period covered by the report. The number of post-offices open for telegraph business on the 31st of March, 1877, is, however, given, and numbers 3,734, in addition to which there were 1636 railway stations open for the transaction of public telegraph work.

Notes.

MESSRS. GERRITT SMITH and HAMILTON, assistant electricians of the Western Union Telegraph Co., have arrived from New York with the quadruplex apparatus, which has been so successfully introduced in America. It has been fixed by the Post office authorities on a London and Liverpool circuit, and according to all accounts has worked admirably. However, the weather, so far, has been everything in its favour, and it has yet to experience the effects of English rain and damp weather. We wish it every success.

THE Telegraph Construction and Maintenance Company's Steamer *Kangaroo* has sailed for Malta in order to complete the new cable of the Bona (Algeria) to Malta section.

M. GAUGAIN has lately undertaken experiments with a view to examine the influence of changes of temperature on the magnetisation of steel bars, and has obtained curious results. He found that, when certain bars were magnetised at a high temperature and cooled, their magnetism entirely disappeared and then changed sign; so that if a bar had been magnetised when hot in a certain direction it was found to be magnetised in the opposite direction after returning to the ordinary temperature. When heated afresh the inverse magnetism, which is always very feeble, vanished, and the primitive magnetism reappeared. The same change of sign is reproduced when the bar is again cooled. The specimens of steel with which these experiments were made were all of Sheffield manufacture. With other bars changes of intensity of magnetism were observed, but no changes of sign. M. Gaugain does not give any very satisfactory explanation of these phenomena.

IN consequence of the great success with which the electric light has been used by Mr. Grothe, the resident engineer at the Tay Bridge, during the last two years, Mr. Jackson, contractor for a large portion of Stobcross Dock, has followed suit, and is now carrying on his work at night by the aid of two powerful electric lights. The lights have been in use during the last two or three weeks from dusk till daylight, and the workmen are thereby enabled to proceed more speedily in the sinking of the cylinders for the foundation of the quay wall. One of the lamps is situated fully 300 yards from the principal part of the cutting, but even at that great distance so powerful is the light that a newspaper can be read quite easily.

THE Eastern Telegraph Company have been advised that the Eastern Extension Company's Singapore-Batavia Cable is interrupted. Messages for Australia and Java are sent by post between the two ports. A special steamer will be put on to carry messages until the cable is repaired.

AT the recent half-yearly meeting of the Direct Spanish Telegraph Company, Mr. Grey asked whether in the event of Bell's telephone being found applicable to ocean cables, the directors would be inclined to test it on their cable, and whether if it could be successfully applied it would not reduce their working expenses considerably? The chairman, as an unscientific man, replied that the board would be happy to reduce expenditure, and augment receipts. Mr. Grey then said that he had some experience of the telephone working between his private office and warehouse, and he believed that if applied to the cable the company might do three times the amount of work, with one-third of the present staff. In the United States it had been used for distances of eighty or a hundred miles, and it had been tried by some of our own Post-office officials on the Dartmouth-Jersey cable with perfect success.

THE *Glasgow Herald* in giving an account of some experiments with the speaking telephone which have been made in Sir William Thomson's Physical Laboratory at the University, records the following amongst the number: "A third interesting experiment made yesterday was that of sending 'Should auld acquaintance be forgot' through the too solid flesh of twelve persons, who entered the circuit and joined hands, an enormous resistance being in this way created. While they were electrically connected, Professor Bell, in the upper floor of the University, sang a line of the old melody, which floated into the ear of the member of the circle who applied his organ to the mouthpiece, and was also faintly heard by the other persons in the laboratory." We have always believed that the Scotch manifested a passionate fondness for their national songs, and especially "Auld lang syne," but we never thought they would carry it so far as to have the favourite melody *sent through them*." This spectacle of a dozen patriotic, but bulky Scotchmen, is too affecting!

LIKE other marvellous things the telephone seems to have established quite a literature of its own. The comic papers have employed it as a vehicle for their wit, and especially for that of a rather far-fetched description. Poets have eagerly welcomed it as a new image, and there have not been wanting preachers who have hailed it as a new symbol. It has been the theme of a great deal of amusing speculation, of which it is difficult to distinguish jest from earnest. For instance the *Herald*, above quoted, goes on to say: "In America, at Boston and Cleveland, Ohio, dwelling houses and places of business are connected by the telephone with a central office. Merchants talk with each other without the intervention of third parties, and therefore in perfect secrecy. Or Brown telephones his wife that he is going to bring Jones and Robinson to dinner at five o'clock to-day, and Mrs. Brown communicates with the central office, directing the attendant there to put her in communication with Brisket the butcher. Her house is straightway switched on to the butcher's shop, and a

joint is ordered. In the same way Mrs. Jones may make known her commissions to the greengrocer or the wine merchant. It is further intended to have the far distant cities of the New World placed in telephonic communication with central offices, where a merchant may buy the use of a wire for five or ten or twenty minutes, as he desires." It is, of course, an easy matter to multiply the probable uses of the telephone. We are surprised that it has not been pressed into the service of the Triple Alliance, and that it is still necessary for Prince Bismark and Count Andrassy to resort to the clumsy and antiquated expedient of having to get themselves transported bodily to Salzburg, or any other place, in order to be able to talk with each other. We should have thought that a triplet of wires between Berlin, Bucharest, Vienna, and three telephones, would have been sufficient for the settlement of European affairs. Perhaps the new proverb "wires have tongues" may have something to do with it.

A MORE publicly authenticated case of priority of invention has just been pointed out by a correspondent in *Nature*. Lodighin's electric light which, with the exception of Jablochkoff's electric candle, is the most successful of recent electric wicks or torches, is shown to have been forestalled by an English patent (No. 10,919, 4th Nov., 1845) in the name of Edward Augustin King. Mr. Mathieu Williams, who draws attention to the fact, states that the real inventor of the early wick was a young American, named Starr. The principle of both Starr's and Lodighin's invention is the employment of a continuous rod of carbon through which the current is sent, instead of two rods separated by an air space as formerly, and the enclosing of the carbon rod in a vacuum or space devoid of oxygen, so that the carbon might not be consumed by oxidation. The practical details employed by Starr and Lodighin differ from each other. For example, Starr employed the Torricellian vacuum, and Lodighin makes use of an exhausted tube, into which nitrogen or other azotic gas has been passed. A thorough research into the electrical records of that mausoleum of misdirected ingenuity, the British Patent Office, would, we have no doubt, reveal many startling and unwelcome facts.

PROFESSOR A. W. WRIGHT, of Yale College, Connecticut, has discovered a means of electro-plating, or coating glass and other vessels with metal films by the action of a succession of powerful electrical discharges. Taking advantage of the fact that the metals may be volatilised by the discharges, he encloses the two poles of a powerful induction coil in a glass vessel, from which the air has been partially exhausted, and suspends the article to be plated between the poles. To the negative pole he attaches a small piece of the metal which is to yield the plating. Under the influence of a spark three inches long the piece of metal is gradually vapourised and projected against the cooler surface of the vessel, where it condenses in a fine film of singular brilliancy. Uniform films of any degree of thickness may be obtained. The light seen through the film varies with the thickness. For platinum it is brown, yellow, or orange, and is complimentary to that for silver, so that by superposing a film of platinum on a film of silver a bright white reflecting surface, suitable for specula, is got. Professor Wright has already made a number of practical applications of his discovery. He produces mirrors by coating glass with silver, platinum, and iron. Platinum as a deposit does not easily tarnish, and can be readily cleaned with acid or water. He deposits gold in a layer 0·000183 mm. thick, or about one-fourth the wave length of a red ray of light. It may be possible by this new art to improve scientific reflecting instruments.

PROFESSOR EMILIO BROGLIO has invented a new voltaic element, which is said to give good results. It is based on the known fact that zinc dissolves in a solution of sulphurous anhydride without the development of hydrogen. When the zinc is immersed in this liquid or in a solution of bi-sulphites of potash and soda, the liquid at first loses colour, then acquires the yellow colour of a solution of bi-chromate of potash.

THE entire September number of the *Archives des Sciences Physiques et Naturelles* is devoted to a biographical sketch of Auguste de la Rive.

SCHWENDLER'S duplex method is now introduced into the telegraph service of Bavaria, and has been working since the beginning of July, under very variable atmospheric conditions, with great rapidity and regularity, to the satisfaction of the Administration. The great productive power of this method must be sought in the stability of the balance, which renders correcting adjustments almost superfluous. It will apply above all to long lines, as has been proved by several years experience in the Indian service. Switzerland and Wurtemburg purpose making early trials with this method in order to study its more extended application. —*Journal Telegraphique.*

IT is reported that a submarine cable is to be laid from Livingstone, Guatemala, Central America, to Cape San Antonio, Cuba, a distance of 450 miles.

THE Western and Brazilian Telegraph Company (Limited) announce the restoration of their cable between Bahia and Rio de Janeiro, and also of the Transandine Companies' lines between Buenos Ayres and Valparaiso.

THE short New Hampshire—Nova Scotia section of the Direct United States Cable is interrupted. The cable having been fouled by the anchor of the schooner *Northern Star*, belonging to Gloucester, Massachusetts. This interruption does not affect the due transmission of messages between Europe and North America, as they are now sent from Torbay, Nova Scotia, by the Company's alternative route, *via* the lines of the Dominion of Canada and Western Union Telegraph Companies.

SIR ALLEN YOUNG intends to refit and equip the Pandora for another voyage to the Arctic regions in spring. One of the Spitzbergen routes will most probably be tried in preference to Smith Sound, which is rightly regarded as having now been well explored, at least, as far as its coast lines are concerned. At a recent meeting Commander Cheyne spoke confidently of the practicability of his plan for reaching the pole by means of balloons. An illustration of the three balloons connected together was given in the *Graphic*, and there is no doubt that the pole could be reached if the balloons could be inflated, and a convenient wind would waft them in the direction of the pole, and bring them back again when the explorers desired. Practical aëronauts, men acquainted with the working of balloons, doubt the practicability of the plan. Commander Cheyne proposes to take iron tanks with compressed gas in them, but no data as to the size of the balloons is given.

TRAFFIC RECEIPTS.

1877.	Anglo-American Co.	Brazilian Sub. Co.	Cuba Sub. Co.	Direct Spanish Co.	Direct U.S. Co.	Eastern Co.	Eastern Ex. Co.	Gt. Northern Co.	Indo-Euro. Co.	Mediterranean Ex. Co.	Submarine Co.	West Coast America Co.	Western and Brazilian Co.	West India Co.
	£.	£.	£	£	£	£	£	£	£	£	£	£	£	£
JAN. ...	37,780	11,469	2,311	983	13,530	42,580	24,147	12,663	... ...	... ...	9,668	2,533*b*	10,100	4,058
FEB. ...	32,330	11,606	2,214	784	15,520	35,050	19,645	12,800	... ...	... ...	8,624	2,980*c*	11,026	3,870
MARCH ...	18,880	11,258	3,025	913	8,110	35,491	22,886	16,115	... ...	... ...	9,915	3,128*d*	11,643	5,854
APRIL ...	18,980	11,539	4,706	1,011	6,930	39,861	23,068	16,151	... ...	... ...	11,324	2,362*e*	10,295	7,729
MAY ...	45,420	12,251	4,109	997	17,370	46,309	25,445	18,427	... ...	... ...	11,048	2,170*f*	10,534	7,508
JUNE ...	40,040	9,742	3,295	887	15,260	45,477	24,126	19,663	... ...	... ...	9,960	4,025*g* / 2,225*h*	10,522	5,541
JULY ...	38,750	9,226	2,959	834	14,820	42,713	22,224	19,187	... ...	... ...	9,943	1,925	7,881	*5,239
AUGUST...	41,170	9,407	*2,900	804	15,700	40,428	25,371	17,998	... ...	... ...	9,683	2,025	8,610	*4,367
SEPT. ...	43,230	9,253	*2,500	836	15,940	35,440	22,113	18,445	... ...	... ...	10,029			*3,976

* Estimated. *b*, four weeks ending 13th January. *c*, four weeks ending 13th February. *d*, four weeks ending 10th March. *e*, four weeks ending 7th April. *f*, four weeks ending 5th May. *g*, four weeks ending 2nd June. *h*, four weeks ending 30th June.

City Notes.

Old Broad Street, Oct. 15, 1877.

WE thought and hoped that for a little while at any rate we had done with Mr. Pender. But we cannot allow a statement in a contemporary to pass unnoticed. We conclude it is true that at a recent meeting of the directors of the Direct Company a resolution was proposed by the chairman and carried, "That all matters appertaining to the business of the Company should be discussed by the board, but, instead of being decided by a vote, be left to be settled by the decision of the chairman." We conclude it is also true that as soon as this resolution had been passed, the chairman proceeded to dispose of a matter personal to himself. In other words, that he settled the fees of the directors, according £700 per annum to the ordinary directors, £800 to the chairman, with an extra £500 per annum to be divided amongst the members of the board, according to attendances. Thus, therefore, has Mr. Pender fulfilled one of the predictions we ventured to make. He first worked himself into the position of chairman of the Direct Company; he has now entered into his reward, and will draw his quarterly cheque for £200 with the happy consciousness that he has earned it—we will not waste our space by repeating how. We should not be surprised, however, if the dictator of the Direct Company has overshot the mark. Mr. Pender was so purely disinterested in all that he did up to the date the resolution was passed, that shareholders may perhaps be somewhat disgusted to find him, after all, estimating his services by vulgar dross. Of course it may be urged that £800 per annum is of no consequence whatever to Mr. Pender. Possibly not. But chairmen of companies who possess autocratic powers do sometimes augment their salaries and turn a pittance into a good thing.

To-day the Eastern Telegraph will pay an *interim* dividend of 2s. 6d. per share on the ordinary shares of the company in respect of the profits for the June quarter. Better late than never. The holders of Six per Cent. Preference Shares can also receive a dividend of 3s. per share for the quarter ending September 30, and the half-yearly interest on the debentures is announced to be payable at Glyn's Bank.

The Eastern Extension Australian and China Telegraph Company, late in the day also,—why are the

accounts of some public companies allowed to get so much in arrear?—the directors having declared an *interim* dividend for the June quarter of 2s. 6d. per share, or at the rate of 5 per cent. per annum, free of income tax.

A quarterly dividend, for the quarter ending Sept. 30, of 1½ per cent., has been declared by the Western Union Telegraph Company of the United States.

"The Colonial Governments, forming the great Australian Confederation," should really study Mr. Abbott's monthly circular. Then, no doubt, the "vague phraseology" which "characterises all Government financial contradictions" would be discarded, and the charming candour which distinguishes Mr. Abbott's documents substituted. Mr. Abbott thinks, however, that it is the intention of the Australian Confederation to ultimately purchase the southern portion of the Eastern Extension Telegraph Company's System, and if the Eastern Extension Company can get good terms, we dare say the purchase may be effected. But, although English cable companies have not been managed as we could wish, we certainly are not prepared to advocate the idea that the control of submarine cable communication would be transferred with advantage into the hands of Government. Governments have already more to do than they can do properly.

We won't try to destroy the laurels Mr. Abbott has crowned himself with. He is welcome to the credit he takes of rescuing the property of the West India and Panama Telegraph Company from the hands of an incapable board. We cheerfully admit that the West India and Panama Company is in a fairly healthy condition at present. As to the Western and Brazilian, we have little hope of it. We are dubious whether Mr. Abbott himself could have improved matters in this case. Things look very blue, and we shall not be astonished to learn that they have arrived at a standstill.

The *interim* dividend for the quarter ending Oct. 18, of the Globe Telegraph and Trust Company will be 3s. per share on the Preference Shares, being at the rate of 6 per cent. per annum, and the ordinary shares at the rate of 4 per cent. per annum.

Matters are still extremely unpleasant in the boardroom of the South Eastern Railway Company. It seems desirable that no time should be lost in restoring peace. Either Sir Edward Watkin should retire with dignity, or his co-directors give way with grace. The shareholders can hardly fail to suffer by a protracted and unseemly quarrel. Nothing that the five directors has urged against Mr. Alfred Watkin has altered our conviction that Sir Edward has been, and may yet be—if he remains there—of great service at the board; nothing that has been pleaded by Sir Edward has changed our opinion that Mr. Watkin can no longer act as locomotive superintendent of the South Eastern Company with credit to himself or with satisfaction to the Company. It may not have been a wise thing to preemptorily dismiss him, and to do it showed bad taste; but it would have been æ wise thing on Mr. Watkin's part to have himself suggested his immediate resignation. With regard to the publication of a confidential letter of Sir Edward's, we happen to know that exactly fifty copies of it were printed by a well-known and first-rate firm, who employed only their most trustworthy men to do the work. A copy was sent to each director of the South Eastern Company, every one of whom acknowledged receipt, and the rest of the copies were handed over to Sir Edward Watkin. Yet the *Railway News* published the entire letter. Each of the directors denies that he furnished our contemporary with the letter, and it is, of course, certain that Sir Edward did not. Sir Edward says that one of the compositors must have betrayed the confidence employed in him by his employers, and the employers have, consequently instructed the detective police to pursue inquiries. We of our own personal knowledge, are familiar with more than one case precisely similar to this—*and the printers were proved to be innocent.*

As we have recently expressed ourselves well satisfied with the progress of the Metropolitan District Company, we cannot reasonably find fault with Mr. Abbott for reprinting an extract from his circular of November, 1875, in which he elaborately reviews the then position of the District Company, and professes his strong confidence in its future. We notice in that extract he lays great stress on the probabilities of the Midland Company running their trains over the line of the District. How is it that the Midland Company have not yet availed themselves of this power? Are the directors waiting until the line from Acton to Hammersmith is finished? The public will welcome Midland carriages and Midland lighting arrangements; but when these are in force, the District Company will have to spend some money to improve their carriages, and lighten the darkness in which their passengers too often travel sorely against their will.

General Science Columns.

[By adding these columns on "General Science" to the TELEGRAPHIC JOURNAL, we hope to increase its usefulness. Some of the discoveries and inventions we shall have to chronicle will be found to have a more or less direct bearing on telegraphy, and others, although wholly unconnected with it, will perhaps be none the less interesting, especially to our numerous subscribers abroad whose other sources for such information may be scanty. The columns will contain the leading scientific advances which take place as time goes on.]

LEVERRIER.—Astronomical Science has sustained a severe loss in the death of Urbain Jean Joseph Leverrier, on Sunday, the 23rd September last. He was born at St. Lô, in the department of La Manche, on March 11th, 1811, and was therefore 66 years of age when he died. He was educated at the "Ecole Polytechnique," and accepted a post under the "Administration des Tabacs." His first published paper was upon a chemical subject, but he soon veered to mathematical astronomy, and continued in it till he died. His second paper struck the key note of all his future labours. It was a review of the secular variations of the orbits of the planets, and was read before the Paris Academy of Sciences in 1839. It attracted the attention of Arago, who requested him to calculate anew the perturbations of Mercury due to the attractions of other bodies. His success in this induced him to do the same for Uranus, and he found that, after making allowance for the perturbing agency of Jupiter and Saturn, there was still a residual perturbation which could only be accounted for by the supposition of an unknown planet somewhere between Jupiter and Uranus. He now set himself to determine the exact position and size of the hypothetical body, and by a feat of remarkable mathematical analysis, he was able to announce to the Academy, on June 1st, 1846, the elements of the orbit, actual position, mass, and period of revolution of the new planet. "None but the rarest genius," says Professor Mitchell, of Cincinatti, "would have dared to reach out eighteen hundred million miles into unknown regions of space to feel for a planet which had displaced Uranus by an amount only about four times the apparent diameter of the planet Jupiter, as seen by the

naked eye—a quantity so small that no eye, however keen and piercing, without telescopic aid, could ever have detected it." On the 18th September, 1846, Leverrier wrote to his friend, Professor Galle, of Berlin, instructing him where to look for the new body, and on the first night of observation, Neptune appeared as predicted, and within a degree of the position its discoverer had assigned to it.

It was now made public that Mr. Adams, a young mathematician, of Cambridge, had been for some years independently at work on the same problem, and had by different methods arrived at almost identical results. This crowning achievement of Leverrier's career is therefore shared by Adams, and the Royal Astronomical Society subsequently linked their names together by awarding a gold medal to each.

The discovery of Neptune determined Leverrier's life work. It had verified his mathematical methods, and he resolved to survey the places and movements of all the members of our system. One great practical result of this labour has been correction of tables of the planetary positions used in determining longitude by lunar observation. The tables of Leverrier are adopted into our Nautical Almanac.

Leverrier became a member of the Legislature for his native department in 1848, and a senator under the Empire in 1852. He directed his energies to the advance of education, and became Inspector General of superior education. On the death of Arago, he became director of the Paris Observatory, a post which he retained till his death, with the exception of a few years, during which he officiated as director of the new Meteorological Observatory. While holding the latter office he was able to establish the service for daily weather reports, by telegraph, from all parts of France, and from neighbouring countries; work which in itself would make an ordinary reputation. He was the recipient of numerous gold medals from the principal scientific societies of the world, and orders of merit from every nation in Europe. The day of his death was the thirty-first anniversary of the discovery of Neptune.

THE MOONS OF MARS.—The recent discovery of two satellites to the planet Mars was characterised by Leverrier as "one of the most important observations of modern astronomy." More is known about the surface of the planet Mars than about any other solar planet; but, owing to their exceeding smallness, its satellites have not hitherto been discovered, although there have not been wanting astronomers who believed that Mars possessed a moon or moons. Mars is, this year, very favourably situated for telescopic observation, being in opposition to the sun near perihelion, and it shines in the south every clear night with a splendour like that of Jupiter. On the night of the 11th August, Professor Asaph Hall, of the Washington Observatory, with the great 26 ins. refracting telescope, first observed the larger and outer satellite. On the morning of the 17th, he discovered the smaller and inner satellite. The news was immediately communicated to the other Observatories of Europe and America, and since then these observations have been well confirmed. The satellites are too small to be measured directly by existing telescopes, and their dimensions can as yet only be inferred from their lustre as compared with other bodies of known size and distance. For instance, there are members of the ring of small planets between Mars and Jupiter, only fifteen miles in diameter, which can be seen by the telescopes which sighted the satellites of Mars, although they are three times further from the earth than Mars is. The diameter of the larger moon is probably about fifteen and not more than thirty miles. Its centre is about fifteen thousand miles from the centre, or about twelve thousand seven hundred miles from the surface of Mars. The diameter of the smaller moon is probably about three or four miles; and its distance from the centre of Mars, nine thousand miles. The satellites revolve in circular paths in a plane near the equator of the planet; the outer completing its circuit in about thirty hours, the inner in about eight hours. From the observed motion of the outer satellite, the mass of Mars has been found to be $\frac{1}{3093000}$ instead of $\frac{1}{3081300}$ of the mass of the sun. The satellites have not yet been named, but it has been proposed to call them *Romulus* and *Remus*.

DISCOVERY OF OXYGEN IN THE SUN BY PHOTOGRAPHY.—This other important American discovery has been achieved by Professor Henry Draper, M.D., well known as the author of the "Intellectual Development of Europe." It has been described by him in a paper read before the American Philosophical Society, and we cannot do better than quote Dr. Draper's own account: "Oxygen discloses itself by bright lines or bands in the solar spectrum and does not give dark absorption lines like the metals. We must therefore change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapours, but as having also bright lines and bands superposed on the background of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, fluorine, carbon, &c., but also may account for some of the so-called dark lines by regarding them as intervals between bright lines . . . . The bright lines of oxygen in the spectrum of the solar disc have not hitherto been perceived, probably from the fact that, in eye observations, bright lines on a less bright background do not make the impression on the mind that dark lines do. When attention is called to their presence they are readily enough seen, even without the aid of a reference spectrum. The photograph, however, brings them into a greater prominence. From purely theoretical considerations, derived from terrestrial chemistry and the nebular hypothesis, the presence of oxygen in the sun might have been strongly suspected, for this element is currently stated to form $\frac{8}{9}$ of the water of the globe, $\frac{1}{2}$ of the crust of the earth, and $\frac{1}{3}$ of the air, and should therefore probably be a large constituent of every member of the solar system. On the other hand, the discovery of oxygen and probably other non-metals in the sun gives increased strength to the nebular hypothesis, because to many persons the absence of this important group has presented a considerable difficulty." In order to get his oxygen spectra for comparison, Dr. Draper employed a powerful induction current sent through Plücker's tubes. The current was supplied by a small 350-light Gramme magneto-electric machine, which could yield a maximum light equal to 500 standard candles, or a current equal to 50 Grove cells, or to one Smee, at will. He usually ran the bobbin armature at 622 revolutions per minute. This produced a current which, through an 18 inch induction coil, with a Foucault's interruptor breaking the circuit of the primary coil 1000 times a minute, gave 1000 ten-inch sparks per minute and lighted the tubes very vividly. It was important to procure a uniform current to keep the bobbin in steady rotation. For this purpose Dr. Draper employed a Brayton's petroleum motor. "This remarkable engine acts like an instrument of precision. It can be started with a match, and comes to its regular speed in less than a minute; it preserves its rate entirely unchanged for hours together. More-

over, it is economical, cleanly, and not more noisy than a steam-engine. The one of two horse-power I have ran for six months, day and night, supplying water and air to the aquaria in the Centennial Exhibition at Philadelphia. At any hour on going into the laboratory it can be started in a few seconds, even if it has not been running for days."

SIEMENS' DIRECT PROCESS IN THE PRODUCTION OF IRON AND STEEL.—In a paper read at the recent Newcastle meeting of the Iron and Steel Institute, Dr. C. W. Siemens gave an account of the further progress of his process for reducing iron and steel at once from the ore, without the necessity of first forming cast-iron, and reducing the pure iron from that, as in the ordinary method. The direct process is the oldest method of reducing iron, and it used to be practised by mixing comparatively rich iron ore in powder with about 25 per cent. of its weight of pounded coal, and then exposing the mixture to the heat of a smith's fire for some hours, when metallic iron was formed, which, on being heated to the welding point, on the smith's hearth, could be forged into a horseshoe of excellent quality. When fluxes, such as lime or clay were added to the mixture they helped to rid the iron of adherent slag. This plan could, however, only be employed on a small scale, and with very pure ores, free from sulphur and phosphorus. The more elaborate plan of reducing to cast iron first, then "refining" and "puddling," has been hitherto found necessary in dealing with large masses of ore of an impure kind. The simplicity of the early process has much in its favour; the iron is of the finest quality, and it is not surprising that attempts have been made from time to time to revert to it; but the fact that only rich ores are applicable, the expense of requisite manual labour great, and that the fuel required should be charcoal, have stood materially in the way. Dr. Siemens conceived that the direct process could be carried out by help of the modern appliances for the production of intense heat, and the manipulation of large masses, and by the aid of an advanced chemistry. He had, in his regenerative furnace a means of producing the necessary degree of heat without the use of charcoal and blowing apparatus. He began experiments, and in 1873 described his results in a paper to the Iron and Steel Institute. He subsequently carried out his process on a practicable scale at his Towcester Works, in Northamptonshire, where he produces rolled bars by the direct process equal to Swedish bar as regards toughness and purity.

He has two modes of carrying on the process; one, by means of a rotary furnace, and the other by means of a stationary furnace. The first mode is suitable to the poorer ores, and the other to the richer ores. The rotary gas furnace charged with ore, fluxes, and reducing agents reduces the metal in about two and a half hours. The slag is then tapped, and the heat of the furnace, and the speed of rotation are increased to facilitate the formation of balls. These balls still contain about 30 per cent. of cinder, but the iron is pure metal, while the slag contains all the sulphur and phosphorus. The balls are taken out of the rotator, and the slag is hammered out of them as in the old refinery or charcoal hearth process.

In the stationary furnace the malleable iron forms as a thick skin on the charge of ore, fluxes, and reducing agents. This skin is drawn out, cut into bars, and finished off like the balls from the rotatory furnace by the hammer.

The "shingled" metal thus produced is good melting material for the open-hearth or Siemens-Martin process of making steel; but when the ores are rich and free from sulphur and phosphorus, Dr. Siemens further simplifies the process by adding hematite pig-iron to the batch, and causing fusion to take place in the reducing furnace itself. The steel so produced is equal in quality to that of the open-hearth process as now practised.

HARD RUBBER or vulcanite placed for several weeks in nitro-benzol, becomes soft and pliable, like leather, and easily broken. T. A. Edison in the *American Chemist*.

THE French government have adopted a "cannon revolver" for use in the navy. It throws eighty shells per minute, each shell weighing half a kilogramme and is effective at a range of 3,000 yards.

VESUVIUS.—There are symptoms of increased activity in the crater of Vesuvius. The glow of fire in the mouth of the crater can be seen by night from Naples. It is stated that Professor Palmieri, who makes the mountain his special study, has this year found great anomalies of temperature at his observatory on the summit; the degree of heat having been as high as 34° C., and the degree of cold as low as 7° C. This degree of cold has only been reached to his knowledge once before during the twenty-five years he has been observing, and the above degree of heat is unprecedented.

MR. JAMES GLAISHER, F.R.S., in a paper read before the Havre meeting of the French Association on the changes of temperature in the atmosphere, with elevation, found from recent experiments in a balloon, that the "change of temperature with increase of elevation has a diurnal range, the change being the greatest at about midday, and the early afternoon hours, decreasing till about sunset, at which time when the sky was free from clouds, there was little or no change of temperature up to the height of several hundred feet."

THERE is a good deal of evidence for believing that the climate of the North of Europe is gradually growing colder. Fossil palms and other vestiges of a tropical vegetation are being discovered in Greenland; but these point to a warm period before the Glacial Age. During the last few years, however, it is said that the Polar ice has encroached southward. This summer has been unusually cold in Norway, owing to floating masses of ice along the coast. Iceland has suffered so much by the cold that it is said the corn no longer ripens there, and the Icelanders are obliged to forsake the Ultima Thule, which has been their home for a thousand years, and emigrate to Canada and the United States.

SCIENTIFIC VOYAGES ROUND THE WORLD.—Excursions round the world, combining pleasure and instruction, are a novel and characteristic feature of our time. The first expedition of the *Societé des voyages d'études autour du monde* is fixed to start on June 15, 1878. The object of this society in promoting annual voyages round the world has been explained by M. Georges Biard in a paper read at the Congress of the French Association for the Advancement of Science. "The spreading of elementary education," he says, "now occupies a great deal of attention, and the most distinguished minds of our epoch study that important question. They could not, assuredly, apply themselves to a nobler or more useful aim, for it is perhaps on the solution of this difficult problem of elementary instruction that the stability of modern society depends. Nevertheless, the mode of instruction of the superior classes has its importance also. Great progress has

certainly been realised in this direction; but if it is true that classical learning does not comprise all the elements of a complete education, well in harmony with the actual movement of ideas, and inspired with the needs of the country, we are led to enquire if nothing can be done for the intellectual amelioration of the upper classes. What a classical education does not give, or only gives imperfectly, is a certain manliness of intelligence which leads the reflections of young men towards what we call 'serious things'; classical education adorns rather than forms the mind, it does not furnish the necessary transition between the preparation for life and life itself. It is necessary then, to create an additional training which shall supply that transition and, to our mind, that training ought to be a great voyage intelligently accomplished." The society numbers amongst its promoters MM. de Lesseps, Dupuy-de-Lôme, and Hipp-Passy. The ship selected for the first voyage will be of the type of mail steamers. It will carry with it complete materials for instruction, books, maps, views, instruments; and special professors will be engaged to deliver lectures or hold conferences. From Marseilles the expedition will set out for Brazil and La Plata, calling at Madeira and other places on the way. From La Plata it will round Magellan and touch at Chili, Peru, Panama, and San Francisco. It will then cross the Pacific to Australia, taking in the Sandwich Islands, Fiji, and New Zealand. From Melbourne it will make for Japan and China, stopping at Shanghai, Hong Kong, and Batavia. From thence it will return homewards by Singapore, Malacca, Calcutta, Madras, Ceylon, Bombay, the Suez Canal, Alexandria, and Naples. From June 15, 1878, to May 15, 1879, fourteen thousand leagues will have been traversed, and five months will have been spent in stoppages at the most remarkable places in the world. Inland voyages may be made by the travellers at their discretion. The total cost of the trip is fixed at 23,000 francs for a private cabin, and 17,000 for a berth in a cabin. Parties of three occupying three-berthed cabins are charged 14,000 francs each.

The American Woodruff Expedition starts on November 1st, in the steamer Ontario on a voyage round the world. The Ontario is a screw steamer, 390 feet long and 46 feet wide, and will be specially fitted and manned for the work she has in hand. The object of the expedition is to visit different parts of the earth of general and special interest, and to study their arts, archæology, geology, botany, and zoology, as well as the history, manners and customs, of the people who dwell in little known regions. The scientific work will be under the supervision of Professor Wilder, of Cornell University, aided by other Collegiate gentlemen. The route will be along the east coast of South America, then up the west coast to Valparaiso. From thence the Ontario will cross the Pacific to Japan and China, and leave will be permitted a portion of the passengers to explore Formosa. The East India Islands will then be visited, and afterwards Calcutta, Ceylon, and Bombay. The antiquities of the East having a special interest for Americans, we are not surprised to find that the expedition will then proceed to Babylon and Nineveh, Egypt, the Holy Land, Greece, Italy and Spain. The Ontario will leave Plymouth, England, homeward bound, in 1879, and return to New York, *via* the Azores. The cost of the trip is £500 inclusive; a very moderate fare for two years of travel.

THE NEW METAL DAVYUM.—This new element, discovered by Sergius Kern, St. Petersburg, and named after Sir Humphry Davy, is a platinoid metal of a silvery lustre, hard, malleable at red heat, readily soluble in aqua-regia, feebly soluble in boiling sulphuric acid, and yielding a yellow precipitate, with caustic potash; sulphuretted hydrogen, passed through a dilute solution of the chloride yields a brown precipitate which becomes black on drying. Potassic sulphocyanide, with the same solution, is coloured red, and if the solution of davyum in K. Cy. S is concentrated, a red precipitate is obtained. The specific gravity of the metal is 9·385 at 25°C. M. Kern thinks that davyum is the hypothetical element placed between molybdenum and ruthenium, in Mendelejeff's proposed classification of the elements. If this is so, its atomic equivalent should be 100, and it would be the second of Mendelejeff's verified predictions. Gallium being the first platiniferous sand, from which davyum was first extracted, does not contain more than ·00045 per cent. of it.

THE different species of the *Eucalyptus* or gum-trees of Australia, promise to be serviceable to man in the arid tracts of the earth, not only for their excellent timber, but for their rapid growth. Forests are well known to render dry climates more humid, and the fast growing gum-tree has been found in a few years to render the dry regions in which they have been planted sensibly moister. The following remarks on the *Eucalyptus* are from the Journal of the Society of Arts: "It is hardly more than fifteen years since the first *Eucalyptus* trees were introduced into Algeria by M. Ramel, and very few indeed exist in the colony of a greater age than ten years; even now it can hardly be said that any attempt has been made to grow them on a great scale. There are many other Australian trees suited to almost every condition of soil found in Algeria, such as the beautiful acacias or wattles, the *grevillia casuarmas*, &c. These are no doubt destined to play an important part in the *reboisment* of the country; but it is the *Eucalyptus* alone which merits to be planted over extensive areas for the sake of its timber. There may be parts of Europe where this tree could be cultivated as well as in Algeria, though that is very doubtful; but hardly anywhere is the price of land sufficiently moderate to enable it to be grown with a certainty of profit. As a rule wherever the orange tree flourishes so does the *Eucalyptus*. In Algeria it attains in six or seven years the same dimensions as the oak does in twenty, and in its twentieth year it may be expected to furnish such logs of timber for ship-building or other purposes as could not be furnished by an oak under a hundred years. . . . The number of species of *Eucalyptus* is great, but for the purpose of commerce two or three species only should be cultivated. The first, the *Eucalyptus globulus*, or blue gum, is best suited to warm positions, deep, fresh, and moist soils. The second, the *E. resinifera* or red gum, resists drought in a remarkable manner, and should be used in poorer or drier soil, or at greater altitudes than the other. It is hardly possible, however, that either of them will thrive well at a greater altitude than 200 or 300 metres above the level of the sea. The third species, which promises well, is the *E. colossea*, but hitherto our experience of it is limited."

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which THE TELEGRAPHIC JOURNAL is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the MANAGER, 10, Paternoster Row, E.C.